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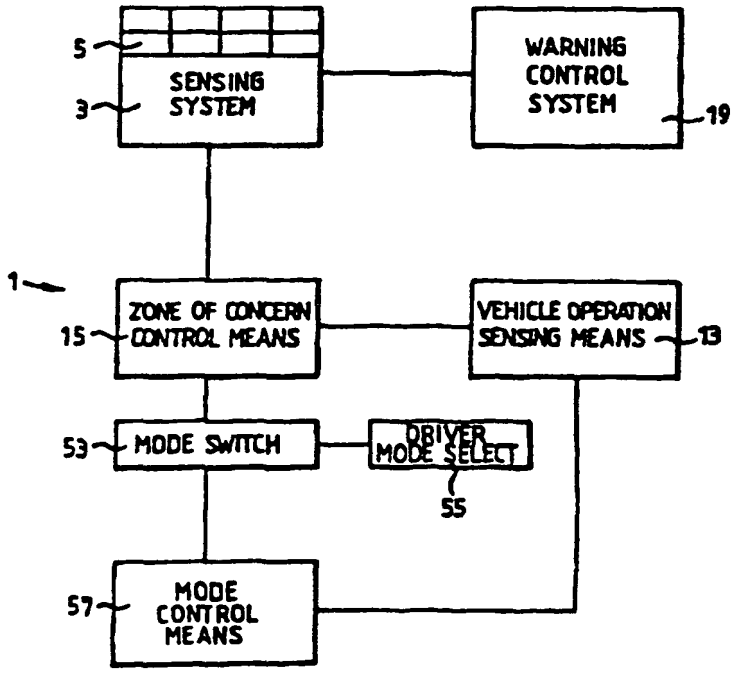
(54) Title: MOTOR ROAD VEHICLE COLLISION WARNING SYSTEM

(57) Abstract

A motor road vehicle collision warning system (1) comprising an obstacle sensing system (3), comprising a plurality of sensors (5) together capable of sensing obstacles in any direction around the vehicle (7) wherein each of said plurality of sensors (5) has a predetermined field of view (9) in which it is capable of detecting obstacles and an instantaneous field of view (10, 11), within which obstacles sensed by the sensor causes the obstacles sensing system (3) to generate an obstacle signal, a vehicle operation sensing means (13) for detecting at least one property of the vehicles operation, a zone of concern control means (15) for defining a zone of concern (17) within which sensed obstacles trigger the generation of an obstacle of concern signal whereby the zone of concern (17) is defined in dependence on the property or properties of the vehicles operation sensed by the vehicle operation sensing means (13), and for controlling the sensors such that the instantaneous field of view of the sensors (5) together cover the zone of concern (17) and a warning control system (19) for receiving said obstacle of concern signals and for determining whether a collision warning signal should be generated.



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Motor Road Vehicle Collision Warning System

Field of the Invention

This invention relates to collision warning systems for motor land vehicles and in particular to road going vehicles.

Various different types of collision warning systems have been proposed for motor vehicles which will warn of potential collision with moving targets, primarily other vehicles, and stationary obstacles especially when parking. Such systems include 'closing vehicle same lane warning systems' for looking behind a vehicle when it is travelling forwards for noting when a vehicle is approaching from the rear, parking aids for looking forwards when the vehicle is travelling slowly forwards and backwards when the vehicle is travelling slowly backwards, backup aids, short range frontal collision warning systems for looking ahead of the vehicle while driving forwards, parking space measuring aids for measuring the length of a parallel parking space to the side of the vehicle, driver induced impaired visibility aids to help ensure that the driver can notice vehicles approaching his side in an overtaking lane, side vision aids for looking to the side of the vehicle and lane change aids for checking that the driver is free to overtake, or indeed move to an inside lane.

Typically these have all been designed as discrete packages and so a vehicle having a multiplicity of these aids includes a plurality of sensors of different types and ranges looking around the vehicle.

There are many different types of sensor available including radar, ultrasonic, capacitive and infrared which are chosen dependent upon the range required for the sensor.

In the specification the term sensor will encompass a transmitter and receiver pair, since the majority of sensor types transmit a signal which is reflected from an obstacle and then received. Measurement of the time delay between transmission and receipt of the signal allows the position of the obstacle to be calculated.

The common features of any of the collision warning systems set out are that they include a sensing system, which has at least one sensor which has a field of view in which it may detect an obstacle and a warning control system which receives obstacle of concern signals from the sensor and analyses them to determine whether a collision warning signal should be generated. This means that false warnings may be avoided, for example noise causes singular false targets. However for each application and at any one time only obstacles in a particular area, known as the zone of concern, are of particular interest. For example in the parking aid, as the vehicle moves forward the area to the front and sides of the vehicle is the zone of concern. During reversing the rear of the vehicle is of primary concern.

The following definitions will be used in the specification

Field of view - the area within which a sensor may be operated to detect the presence of an obstacle. For any sensor the field of view is constant, covering the entire area in which the sensor may be operated to detect obstacles;

Instantaneous field of view - the area within which the sensor may detect the presence of an object at any one time at its instantaneous setting or mode of operation. The instantaneous field of view may be altered by changing the settings of the sensor, for example one or other of the

sensors may be switched off, or by altering the mode of operation of the sensor;

Zone of concern - the area within which the presence of an obstacle causes the sensing system to feed an obstacle signal to the warning control system.

The zone of concern lies within the instantaneous field of view of the whole sensing system. For example in front collision warning, even if the sensors may look behind and to the side of the vehicle, this is not relevant to the warning system. In previous systems the field of view is designed to be the zone of concern, so that if the zone of concern is changed, then the field of view of the sensing system also needs to be changed.

Statement of Invention

A motor road vehicle collision warning system comprising an obstacle sensing system, comprising a plurality of sensors together capable of sensing obstacles in any direction around the vehicle wherein each of said plurality of sensors has a predetermined field of view in which it is capable of detecting obstacles and an instantaneous field of view within which obstacles sensed by the sensor causes the obstacle sensing system to generate an obstacle signal, a vehicle operation sensing means for detecting at least one property of the vehicles operation, a zone of concern control means for defining a zone of concern within which sensed obstacles trigger the generation of an obstacle of concern signal whereby the zone of concern is defined in dependence on the property or properties of the vehicles operation sensed by the vehicle operation sensing means, and for controlling the sensors such that the instantaneous field of view of the sensors together cover the zone of concern and a warning control system for receiving said

obstacle of concern signals and for determining whether a collision warning signal should be generated.

The sensing system remains capable of sensing within the entire field of view but only takes notice of what is within the zone of concern. The field of view is constant for any sensing system, but the zone of concern changes dependant on what the vehicle is doing.

The zone of concern may change in accordance with the method of operation of the sensors within the system, i.e. when the instantaneous field of view changes, or the sensor signals may be interpreted in a different way dependant upon the operation of the vehicle.

The vehicle operation sensing means may operate to sense the speed of the vehicle, the gear chosen (whether forward or reverse), the steering angle, the operation of the direction indicators and the operation of the brake.

The vehicle speed sensor may be coupled to the vehicles speedometer or alternatively may be a separate sensing means.

A first example of a collision warning system in accordance with the invention is a parking aid where the vehicle will move alternately forwards and backwards whilst manoeuvring into position. The sensing system will have at least one sensor facing forwards and at least one facing backwards. The property of operation of the vehicle which is sensed is whether the vehicle is moving forwards or reversing. The zone of concern then alters to the view of the forwardly facing sensor when the vehicle moves forward, and to the view of the rearwardly facing sensor when the vehicle is reversing.

In such a system the vehicle operation sensing means includes a gear selected sensor. Preferably the system also includes a steering angle sensor. When a vehicle is reversing in a straight line, the zone of concern is the area directly behind the vehicle. However if the vehicle is being steered around a bend, then the zone of concern is to the rear and the side, the zone changing dependant upon the steering angle.

Similarly, in a frontal collision warning system the area within which an obstacle will cause a potential hazard will depend on the direction of movement of the vehicle, i.e. upon the steering angle. Preferably also in this system one of the modes of operation of the vehicle sensed is the steering angle.

Preferably the collision warning system is a multifunctional system being capable of acting in at least two sensing modes, and including a mode switch for switching between modes of sensing.

The term 'sensing mode' means a type of collision warning method in which obstacles in a particular zone are monitored for a particular purpose, such as front collision warning, parking aid or side vision aid. The mode switch may be actuated by a driver select control. Preferably however the mode switch is actuated by mode control means which receives signals from the vehicle operation sensing means to determine the type of sensing mode required. This ensures that only one set of sensors is required to achieve a plurality of warning signals, as opposed to a variety of dedicated sensing systems for each function.

Preferably the system is capable of operating in more than one mode at any one time. In this case however it is essential to distinguish between different types of collision warning signal.

Preferably the system also includes a warning display which displays to the driver the mode of operation of the collision warning system and the type of collision warning generated.

Although a number of types of sensor may be used, the preferred method of sensing is an impulse radar method in which the transmitted signal comprises a succession of pulses, in which the sensing system includes transmitter and antennas and means for detecting the presence or absence of a reflecting target at a predetermined set of ellipsoidal range shells. From this the detection of an obstacle can be accurately and efficiently effected.

Such a system includes transmitting and receiving antenna menas mounted in positions such that in use the system may detect obstacles around the vehicle.

Preferably the antennas and transmitters are mounted at each corner of the vehicle in the region of the bumpers. Thus there are at least four transmitters and receiver antennas. In most cases an obstacle will lie in the area of overlap between two sensors. This allows the angular position of the obstacle to be measured which with the range is used to pinpoint the obstacle for an accurate position.

Brief Description of the Drawings

A motor road vehicle collision warning system in accordance with the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of the key components in the system;
Figure 2 is a diagram illustrating the zone of concern for specific modes of operation of the system;

Figure 3 is a schematic plan of a vehicle illustrating sensor position;
Figure 4 is a diagram illustrating the instantaneous field of view of one sensor;
Figure 5 is a diagram illustrating the overlap between the fields of view of two sensors;
Figure 6 is a view of the whole field of view of the sensing system;
Figure 7 is a schematic view illustrating calculation of an obstacles position;
Figure 8 is a plan diagrammatic view of a vehicle fitted with an impulse radar system;
Figure 9 is a block diagram of the radar system shown in figure 8;
Figure 10 is a diagrammatic side view of the vehicle, illustrating operation of the radar system; and,
Figures 11 and 12 show the 'stereo signature' produced by the system on detection of a car.

Description of the Preferred Embodiment

A motor road vehicle collision warning system 1 comprising an obstacle sensing system 3, comprising a plurality of sensors 5 together capable of sensing obstacles in any direction around the vehicle 7 wherein each of said plurality of sensors 5 has a predetermined field of view 9 in which it is capable of detecting obstacles and an instantaneous field of view 10,11, within which obstacles sensed by the sensor causes the obstacle sensing system 3 to generate an obstacle signal, a vehicle operation sensing means 13 for detecting at least one property of the vehicles operation, a zone of concern control means 15 for defining a zone of concern 17 within which sensed obstacles trigger the generation of an obstacle of concern signal whereby the zone of concern 17 is defined in dependence on the property or properties of the vehicles operation sensed by the vehicle operation sensing means 13, and for controlling the sensors

such that the instantaneous field of view of the sensors 5 together cover the zone of concern 17 and a warning control system 19 for receiving said obstacle of concern signals and for determining whether a collision warning signal should be generated.

Figure 2 illustrates the zones of concern about the vehicle in which in particular modes, the presence of an obstacle should generate a warning signal. Throughout these zones of concern the preferred elevation coverage will be from about 0.15m up to the height of the vehicle. Clearly objects above this height such as bridges may be ignored.

The zone of concern 21 for the closing vehicle same lane system covers the lane width within which the vehicle travels , usually 3.7m and extends 30m to the rear of the vehicle. The zone of concern 23 for the parking aid is in two areas 25 and 27 to the front and rear of the vehicle respectively. The area 25 to the front of the vehicle extends 0.6m to the front of the vehicle and 0.5m to each side and the rear area 27 extends 1.5m to the rear for a car, but would be 3m for a van and 0.5m to each side of the vehicle.

The zone of concern 29 for a backup aid extends 10m to the rear and is wider than the vehicle allowing for turning of the vehicle.

The side vision aids zone of concern 31 extends from the wing mirror (not shown) of the vehicle to the rear by 12m and a lanewidth to each side.

The zone of concern 33 for the Driver Impaired Visibility Aid is to the side only of the vehicle and a subpart of the zone of concern 31 of the side vision aid.

The zone of concern 35 for the frontal collision warning extends 10m to the front of the vehicle and extends wider than the vehicle to allow for turning of the vehicle.

The layout of the sensors is illustrated in figure 3 which illustrates four sensors 37,39,41 and 43 each mounted inside the bumpers 45 of the vehicle by connectors 47. Each is part of the sensing system 3. Each sensor in fact comprises a transmitter 37t,39t,41t and 43t and a receiving antenna 37r,39r,41r and 43r. The central unit 49 includes a power supply for the sensors and houses the zone of concern control unit.

Figure 4 illustrates the instantaneous field of view of sensor 37t when its signal is received by receiver 39r.If figure 5 is referred to, it can be seen that by use of two of the sensor/receiver combinations an overlapped area 51 is created within which two sensors can detect the obstacle.

As can be seen in figure 7 if the range from one sensor R1 is known ,and the range from second sensor R2 is also known, together with the distance between the two sensors D, this can be used to plot the coordinates X and Y of the obstacle.

Figure 6 illustrates the field of view of the whole system of sensors. Because the signal from for example transmitter 37t can be received by receivers 39r at the front of the vehicle, and 41r at the rear of the vehicle, these overlapping areas are created.

Thus areas 10 and 11 are instantaneous fields of view of the sensor, chosen dependant on the direction of movement of the vehicle and the mode of sensor required.

The system is a multifunctional system capable of operating in all the modes set out and shown in figure 2. As can be

seen in figure 5, the field of view of all the sensors allows all the zones of concern to be covered.

The system also includes mode switch 53 which is coupled to driver select control 55 allowing the selection of a mode of operation, for example if the driver is about to park. It is also coupled to mode control means 57 which receives signals from the vehicle operation sensing means to determine the type of sensing mode required.

For example selection of reverse gear would trigger reversing aid, a forward gear and the selection of the indicator would trigger the side vision aid. Driving at speeds of over 5 m.p.h in a forwards direction would trigger the Closing Vehicle Same Lane Aid and the Frontal Collision Warning Aid. These operate at the same time. Whilst these are in operation, a display (not shown) indicates to the driver which aid is in operation.

The parking aid is triggered only by selection by the driver by the driver select control.

The method of sensing is illustrated in figures 8 to 12 in which a vehicle 7 includes a radar transmitter 59 and antenna 61 mounted in the rear bumper 45 of the vehicle 7. The transmit and receive antennas are respectively positioned at the regions of the rear nearside and rear offside corners of the car.

The sensors are impulse radar sensors and the antenna 61 transmits a series of pulses. The transmitted signal is in the form of a short radio frequency pulse, typically of 0.1 to 5 nanoseconds duration depending on the rise time and the frequency response characteristics of the antenna.

The pulses are similar to those generated by the system shown in published application WO 90/13048. The transmission

of pulses by the antenna 59 is initiated by a timing generator 63 which triggers a transmit generator 65 of a transmitter 67 connected to the transmit antenna 59.

The timing generator 65 is also connected to two gating devices 69 and 71 which are, in turn, both connected to the receive antenna 61. Each of the gating devices, in response to a signal from the timing generator 65 samples the signals received by the antenna 61.

The outputs from the gating devices are connected to a signal and control processor 73 which analyses the signal to determine whether or not to initiate an alarm or control interface.

The processor 73 is also connected to a motion sensor (not shown) which measures the speed with which the car is moving, and to the vehicle control system.

In use, the timing generator 65 causes a selected one of the gating devices to sample the output of the receive antenna 61 at a predetermined delay (normally of 1 to 200 nanoseconds corresponding to 15cm to 30m) after the transmission of a given pulse by the antenna 59. If the antenna 61 receives the reflection of the pulse during a given sampling period, this is indicative of the transmit pulse having travelled from the antenna 59 to a reflecting surface and back to the antenna 61 in the delay between the transmission of the pulse and the sampling period.

From this information, it can be deduced that the reflecting surface lies somewhere on a range shell, for example the range shell 75 in figure 8, the distance of which from the vehicle 7 is such that the time taken for a pulse to travel to the range shell and back to the vehicle 7 is the same as the delay between the transmission of the pulse and the sampling period.

Thus, the range shell can be considered to be in the form of a part ellipsoidal shell having antennas 59 and 61 at its foci. Each range shell may not take the form of a full ellipse enveloping the car because the transmit and receive antennas 59 and 61 may not provide all round coverage.

As can be seen in figure 10, the sensors operate a series of range shells of different distances to pinpoint the target.

The graphs of figures 11 and 12 depict the type of output from the antenna indicating the position of the vehicle 7.

Claims

1. A motor road vehicle collision warning system comprising an obstacle sensing system, comprising a plurality of sensors together capable of sensing obstacles in any direction around the vehicle wherein each of said plurality of sensors has a predetermined field of view in which it is capable of detecting obstacles and an instantaneous field of view within which obstacles sensed by the sensor causes the obstacle sensing system to generate an obstacle signal, a vehicle operation sensing means for detecting at least one property of the vehicles operation, a zone of concern control means for defining a zone of concern within which sensed obstacles trigger the generation of an obstacle of concern signal whereby the zone of concern is defined in dependance on the property or properties of the vehicles operation sensed by the vehicle operation sensing means, and for controlling the sensors such that the instantaneous field of view of the sensors together cover the zone of concern and a warning control system for receiving said obstacle of concern signals and for determining whether a collision warning signal should be generated.

2. A collision warning system according to claim 1, in which the vehicle operation sensor includes means to detect the gear selected.

3. A collision warning system according to claim 1 or 2, in which the vehicle operation sensor detects steering angle and varies zone of concern dependant upon the direction of travel of the vehicle.

4. A collision warning system according to claim 1,2 or 3 which is multifunctional and capable of operating in at least two sensing modes including a mode switch to select

the mode of operation.

5. A collision warning system according to claim 4, in which the mode switch is operated in accordance with a driver select switch.

6. A collision warning system according to claim 4,in which the mode switch is coupled to a mode control which receives signals from the vehicle operation sensing means and determines the mode required from properties of the vehicles operation.

7. A collision warning system according to claim 4, in which the system may operate more than one mode at the same time.

8. A collision warning system according to claim 4, including a display for displaying to the driver the mode of operation of the system.

9. A collision warning system according to claim 1, including a display indicating to the driver the type of collision warning signal generated.

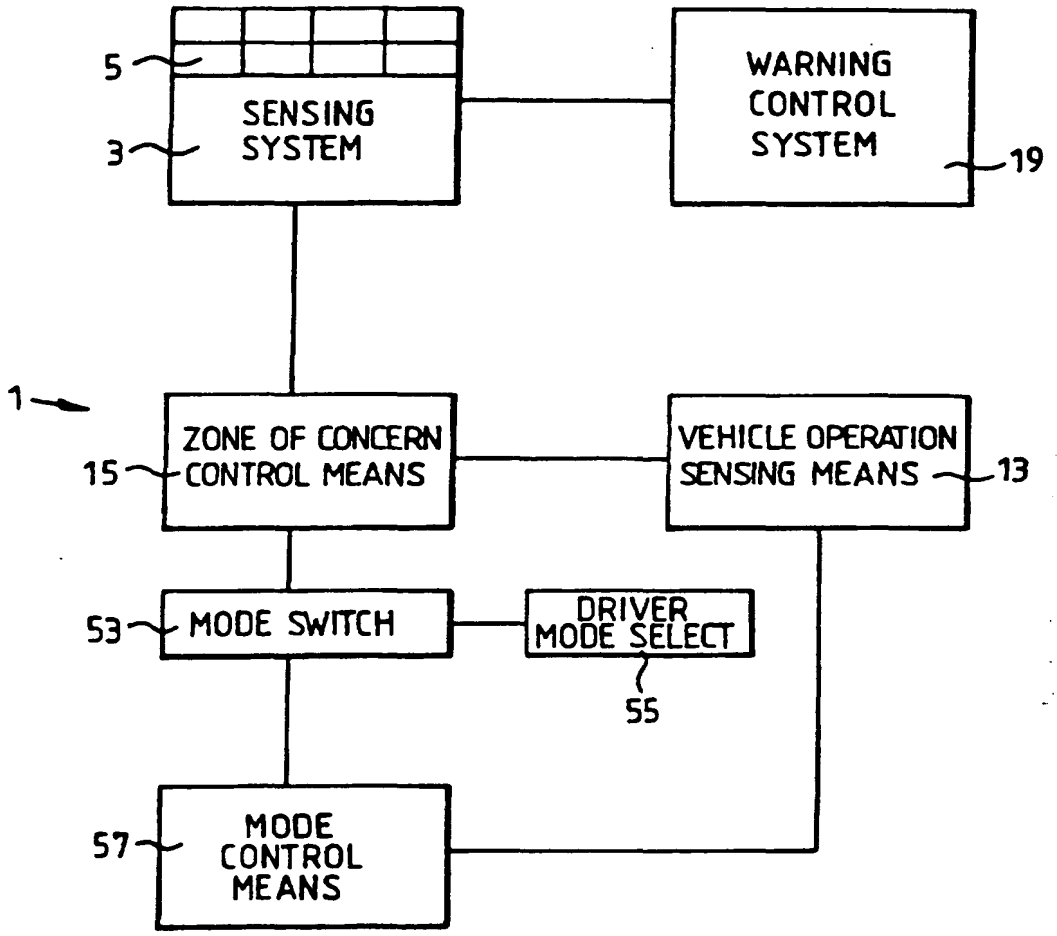
5
SENSING SYSTEM
3
WARNING CONTROL SYSTEM
19
1
ZONE OF CONCERN CONTROL MEANS
15
VEHICLE OPERATION SENSING MEANS
13
53
MODE SWITCH
DRIVER MODE SELECT
55
57
MODE CONTROL MEANS

FIG.1

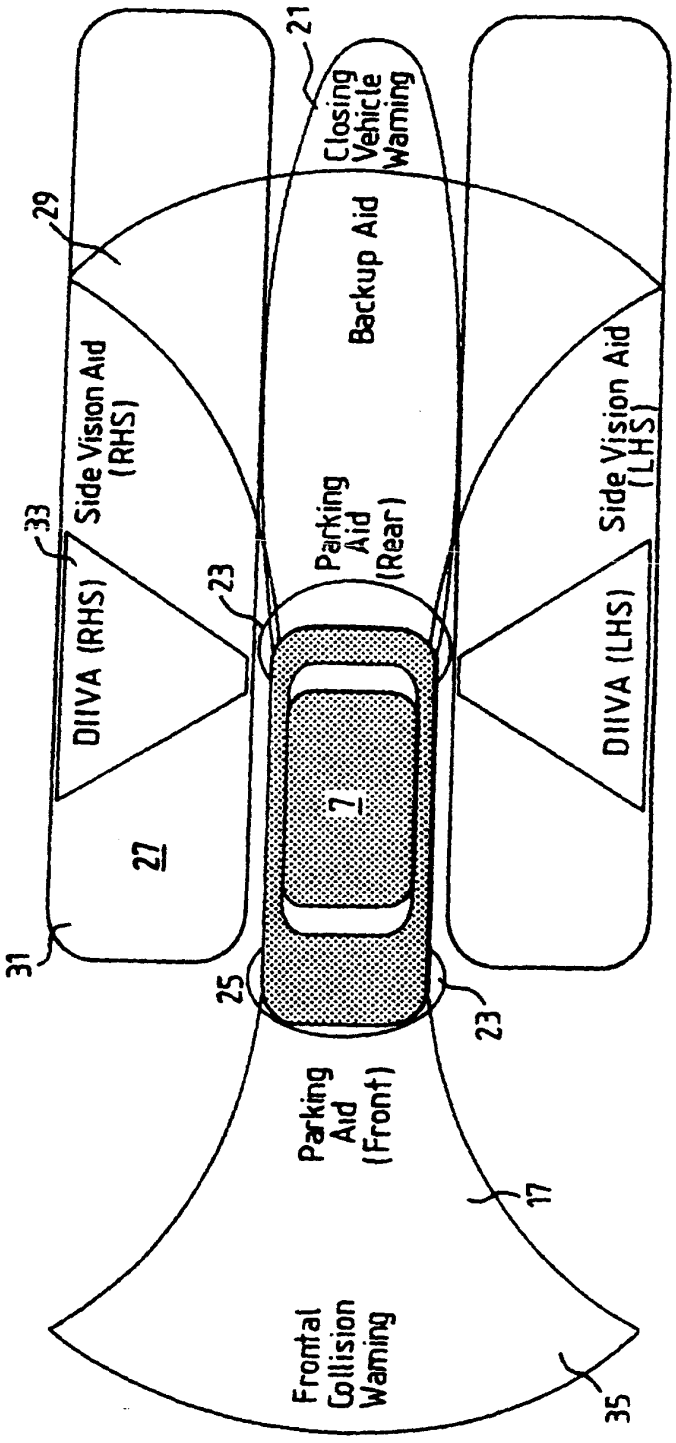
21
Closing Vehicle Warning
29
Backup Aid
Side Vision Aid (RHS)
Side Vision Aid (LHS)
33
Parking Aid (Rear)
23
DIIVA (RHS)
DIIVA (LHS)
7
27
31
25
23
Parking Aid (Front)
17
Frontal Collision Warning
35

FIG.2

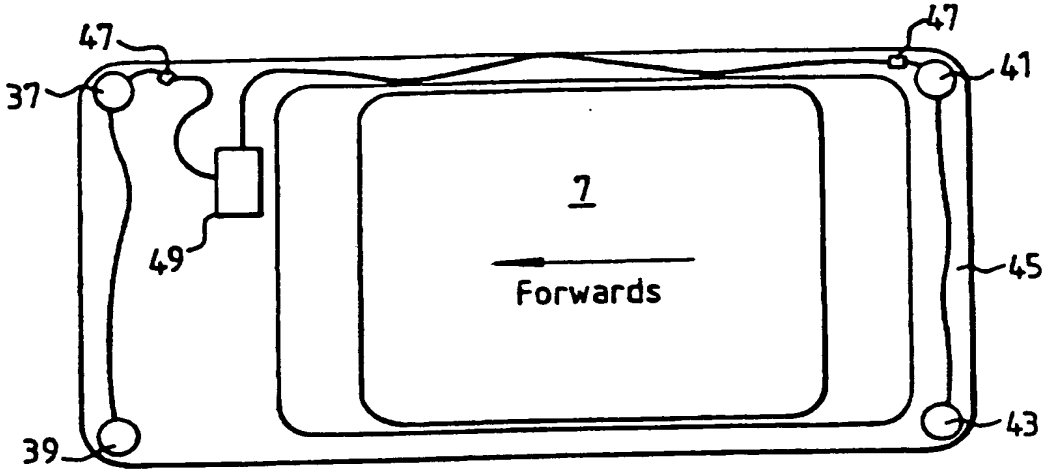

FIG.3

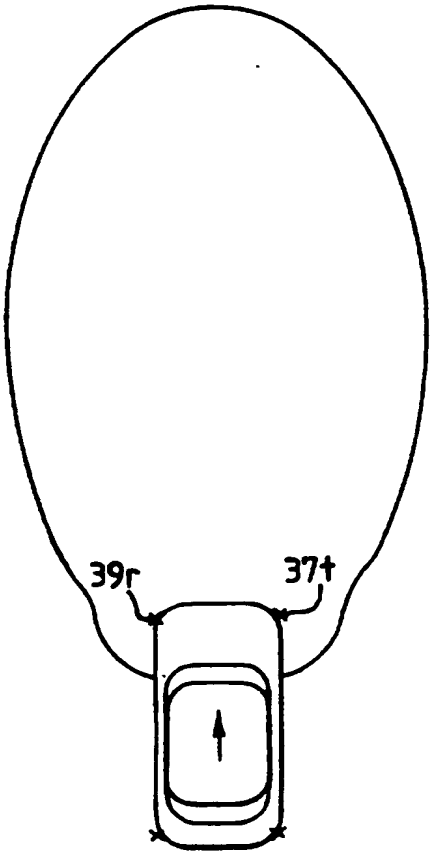

FIG.4

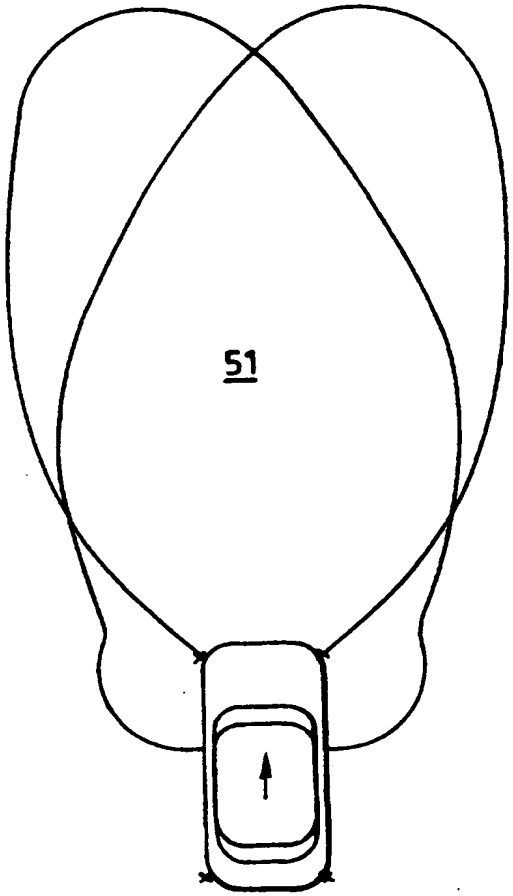

FIG.5

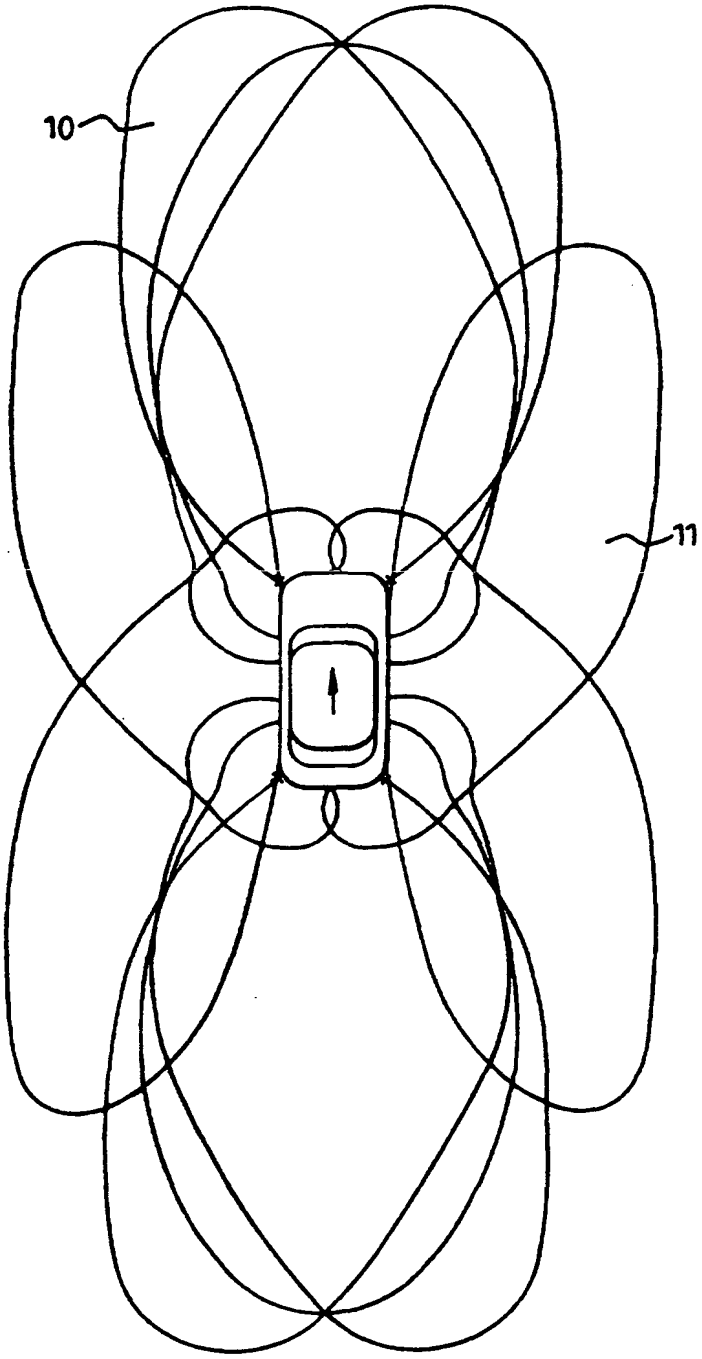

FIG.6

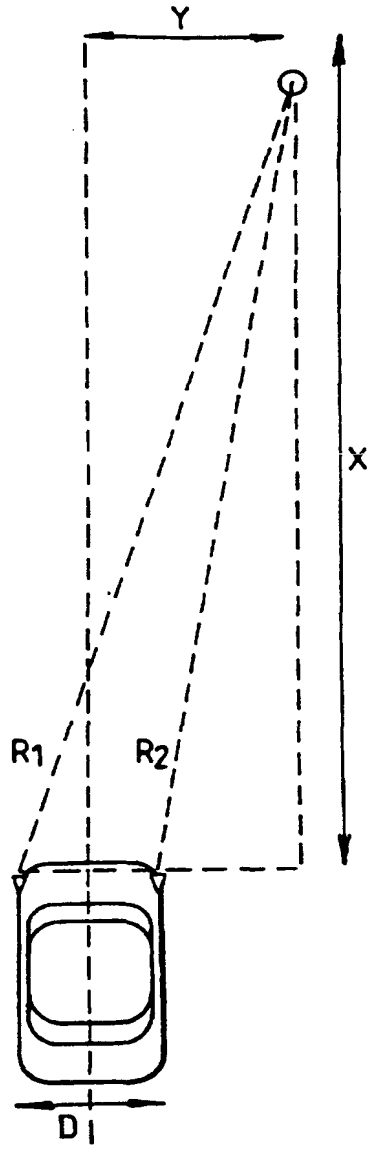

FIG.7

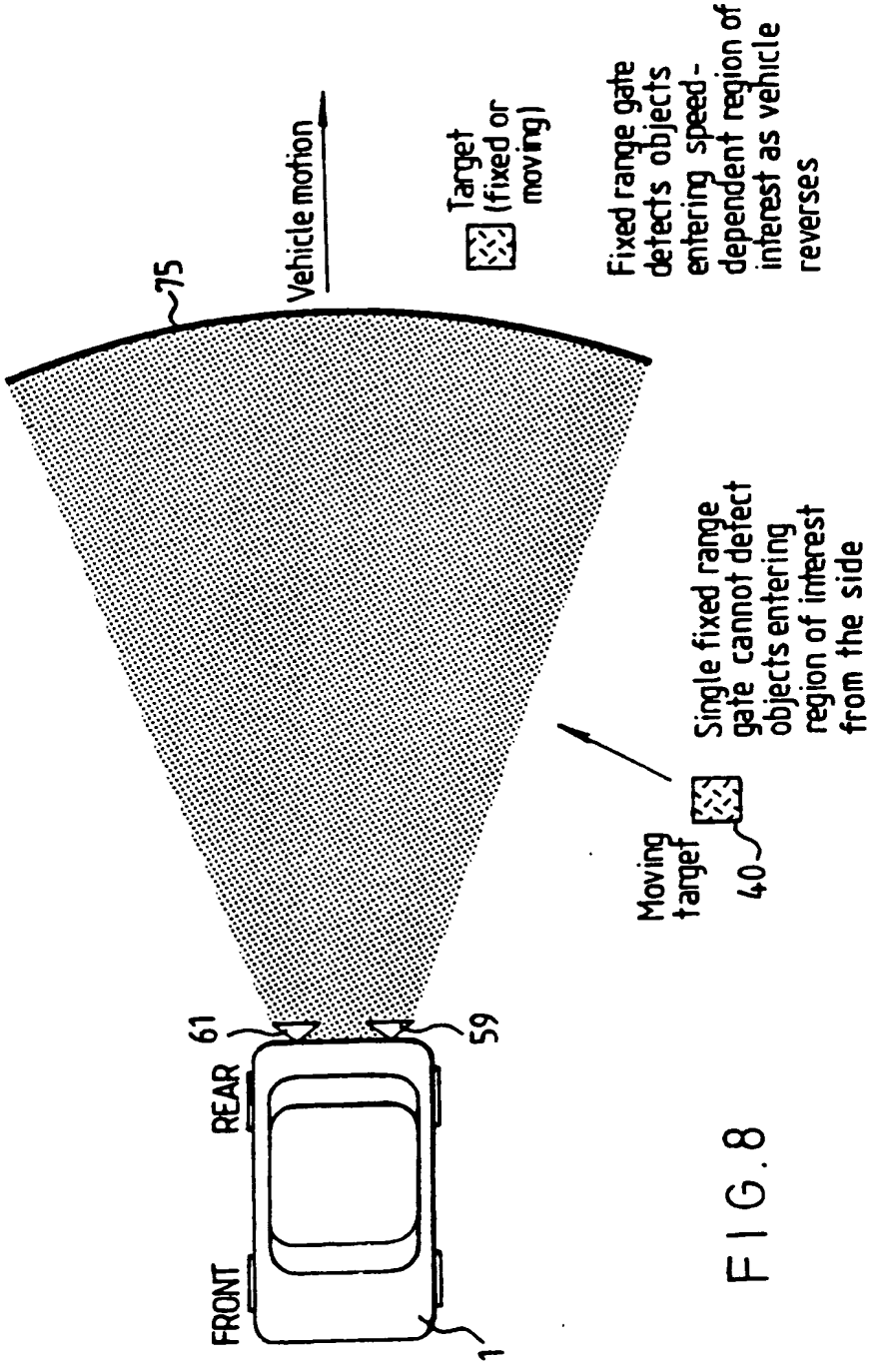
Vehicle motion
Target (fixed or moving)
Fixed range gate detects objects entering speed-dependent region of interest as vehicle reverses
15
Single fixed range gate cannot detect objects entering region of interest from the side
Moving target
40
61
59
REAR
FRONT
1

FIG. 8

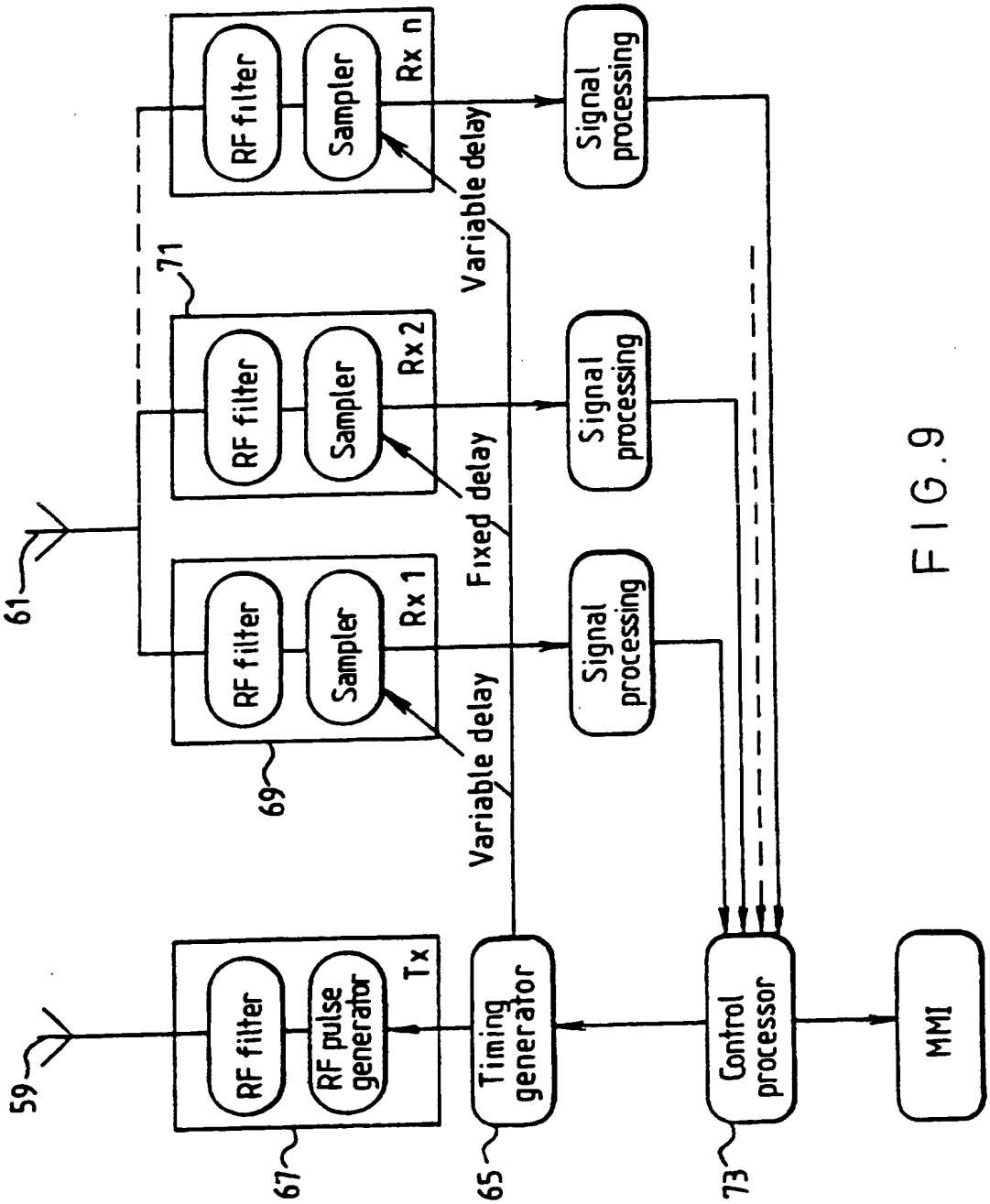
RF filter
RF pulse generator
Tx
Sampler
Rx 1
Rx 2
Rx n
Variable delay
Fixed delay
Variable delay
Signal processing
Signal processing
Signal processing
Timing generator
Control processor
MMI
59
61
67
69
71
65
73

FIG. 9

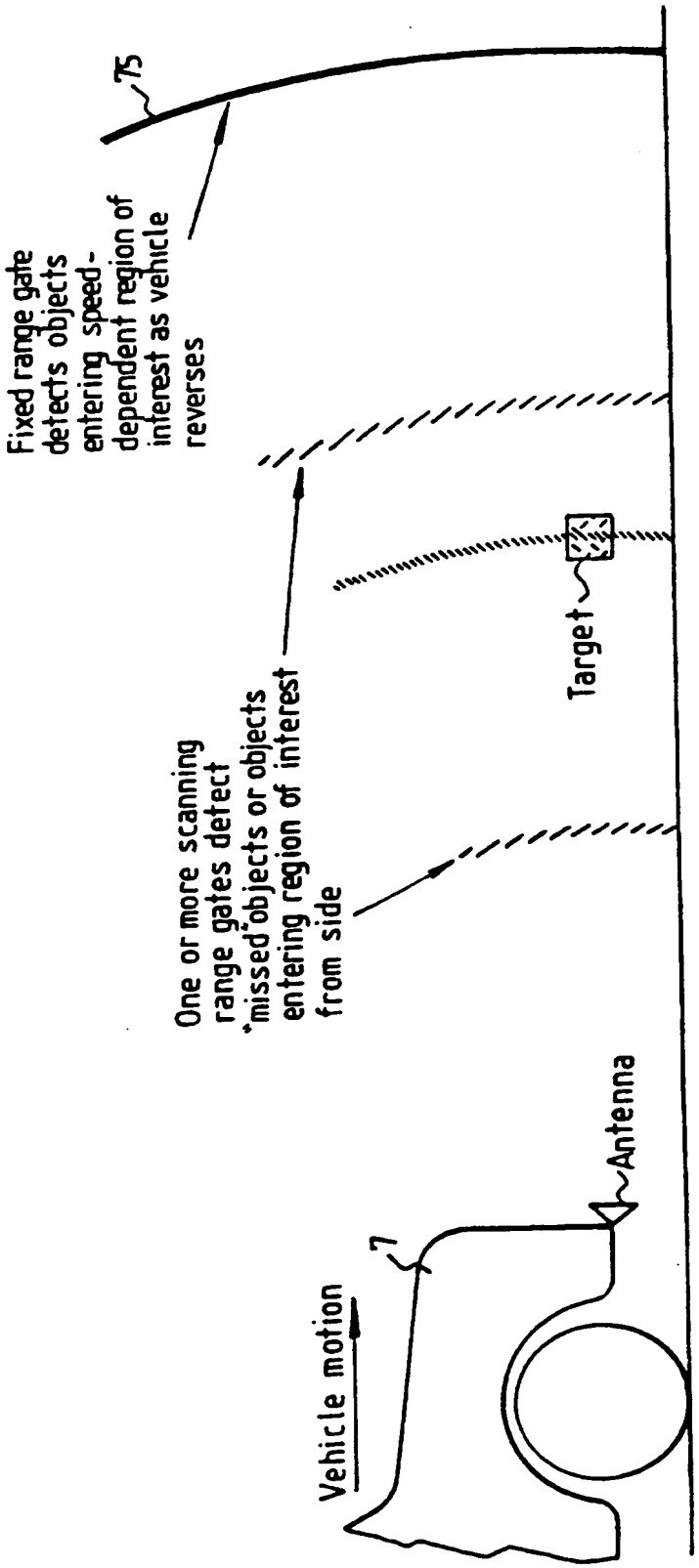
75
Fixed range gate detects objects entering speed-dependent region of interest as vehicle reverses
Target
One or more scanning range gates detect missed objects or objects entering region of interest from side
Antenna
7
Vehicle motion

FIG.10

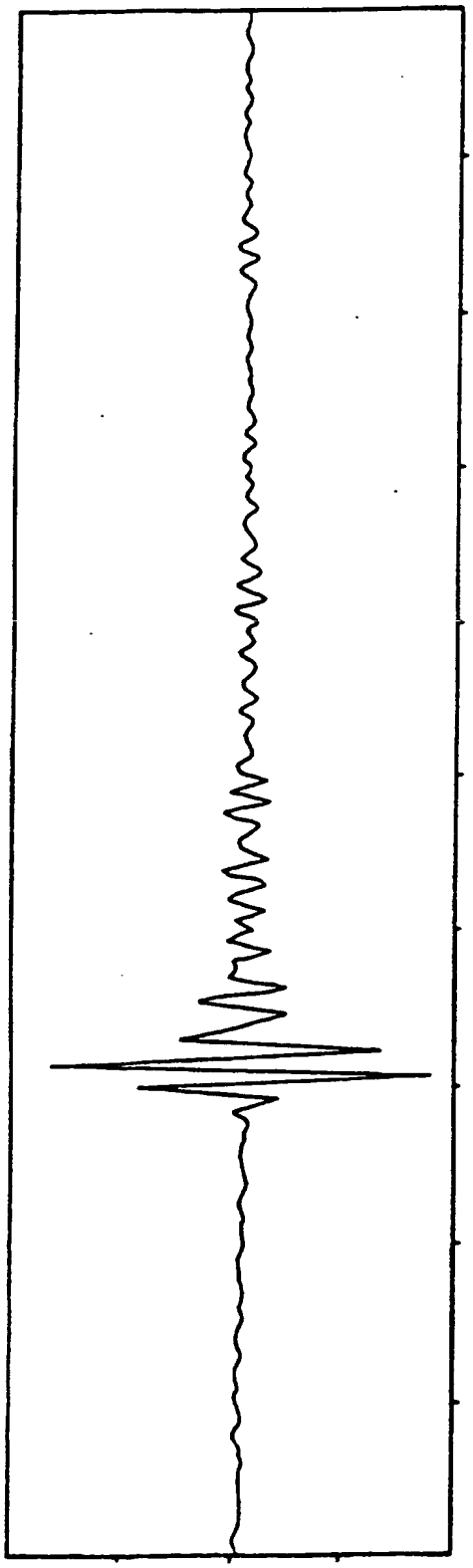

FIG.11

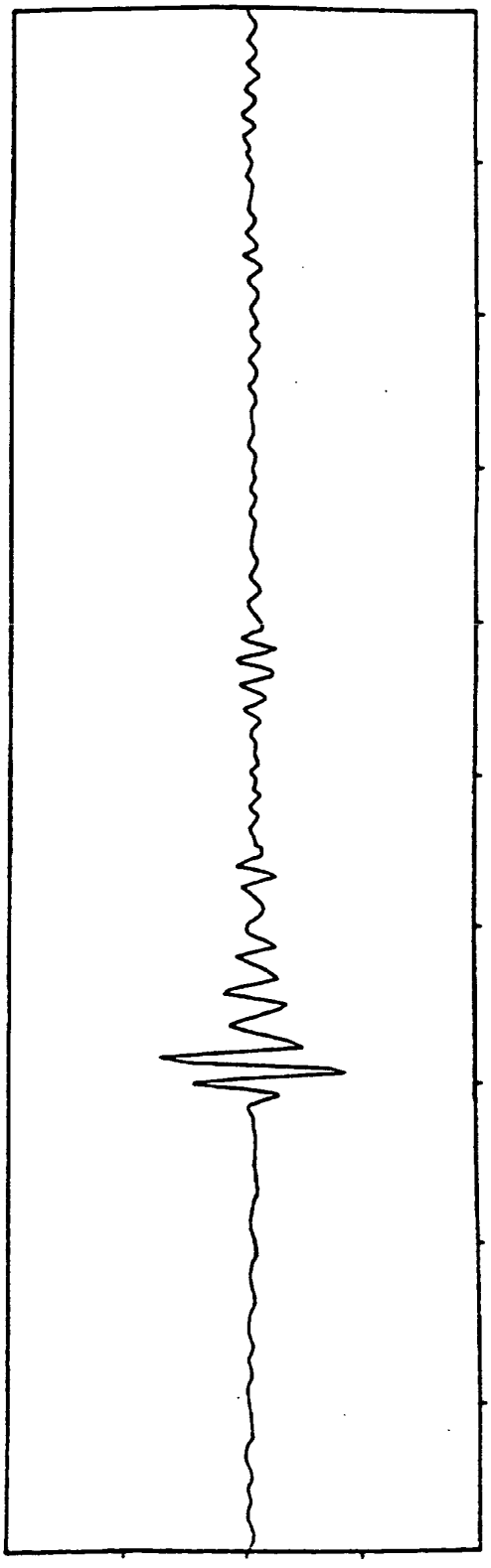

FIG.12

INTERNATIONAL SEARCH REPORT

Inten. . .onal Application No
PCT/GB 97/01728

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01S13/93

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	EP 0 717 290 A (HONDA MOTOR CO LTD) 19 June 1996 see the whole document	1,9 2-5,8 6
Y	WO 96 14591 A (RASHID CHARLES) 17 May 1996 see page 10, line 3 - line 20; figure 1	2
Y	EP 0 657 857 A (MAZDA MOTOR) 14 June 1995 see page 5, line 18 - line 25	3
Y	US 5 357 438 A (DAVIDIAN DAN) 18 October 1994 see column 6, line 6 - line 24; figure 2	4,5,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 September 1997	13.10.97

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter ...ional Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0717290 A	19-06-96	JP 8166448 A	25-06-96
WO 9614591 A	17-05-96	AU 4199796 A	31-05-96
EP 0657857 A	14-06-95	JP 7220199 A	18-08-95
		US 5648905 A	15-07-97
US 5357438 A	18-10-94	IL 102097 A	26-05-95
		EP 0643854 A	22-03-95
		WO 9324894 A	09-12-93